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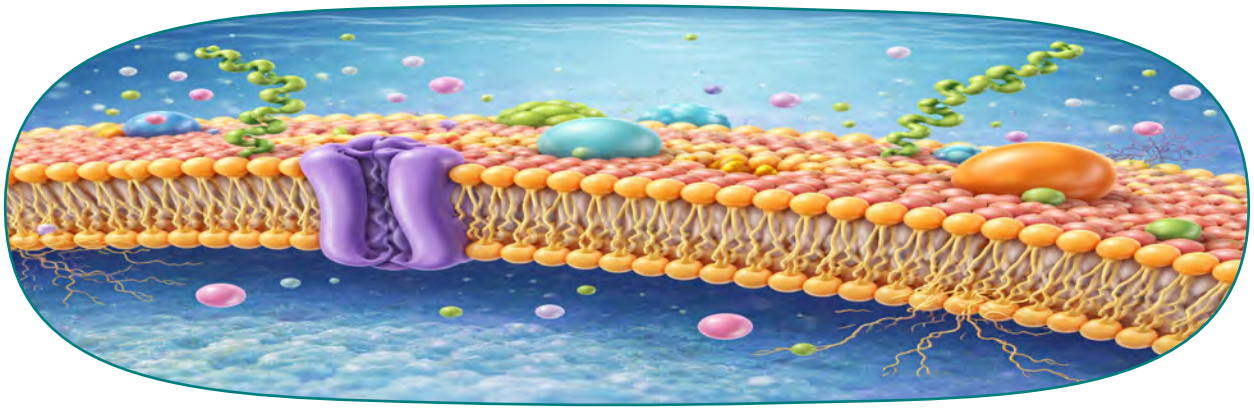

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- Important Concepts with their Descriptions
- Topicwise Questions with Answers
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- Practice Exercises for Self Evaluation

Objective Type QUESTION BANK
(With Answers)

- ✓ MCQs ✓ Fill in the Blanks
- ✓ True/False ✓ Match the Columns
- ✓ Assertion & Reason Questions
- ✓ Case Based Questions

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CLASS IX

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SCIENCE

Study Material

EXPLORATION

Based on New EXPLORATION Textbook and CBSE Guidelines

CLASS IX

- Interesting Mind Map
- Important Concepts with their Descriptions
- Solved NCERT Exercises/Intext Questions and Activities
- Topicwise Questions with Answers
- Practice Exercises for Self Evaluation

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Preface

We are pleased to announce the publication of the revised and updated edition of Golden® **Science** for Class IX, aligned with the latest NCERT textbook (EXPLORATION) as per new **National Education Policy (NEP) 2020 and National Curriculum Framework for School Education (NCF-SE) 2023**. This edition has been meticulously crafted to ensure seamless alignment with the current academic requirements.

Special features of the book are:

- It has been designed as a help book as well as a textbook.
- It has been written in a lucid style and simple language.
- Each chapter begins with a brief summary indicating basic concepts/important terms and formulae used.
- All exercises of the NCERT textbook and intext questions have been given with complete answers at proper places.
- In each chapter, short and long questions are arranged to facilitate the students to understand the subject easily.
- Objective type Question Bank (Multiple Choice Questions, Assertion & Reason type Questions and Case Based Questions) with Answers are given in each chapter.
- Each section deals with problems related to particular science principle. The unsolved problems in the exercise have also been classified in the parallel manner.
- Modern Periodic Table in multicolour is given to aid students' learning.

We are confident that Golden® Science IX will be well received by all. Any suggestions for the improvement of the book shall be gracefully appreciated and accepted.

We value the feedback and suggestions from educators and students, which have been instrumental in refining this edition. Their insights will continue to guide us in future updates.

We are confident that this book will serve as an indispensable resource in your academic journey, enabling you to achieve excellence in Science. We strive to provide a comprehensive learning experience and support your academic success.

Authors

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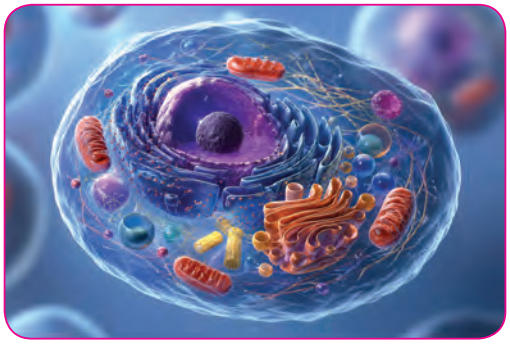

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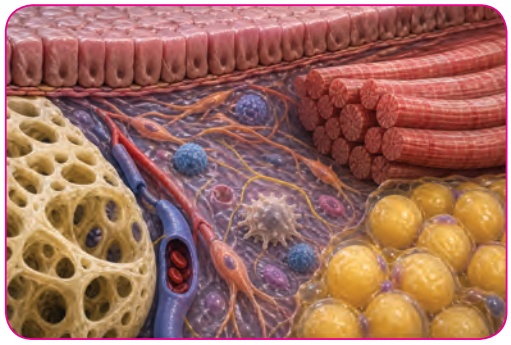

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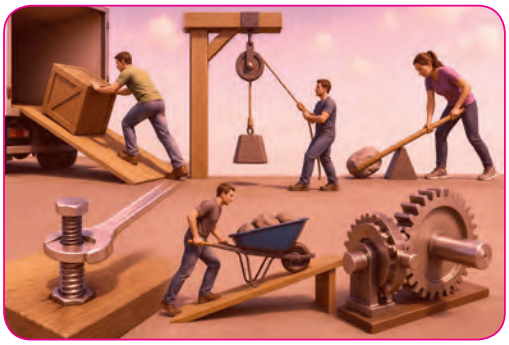

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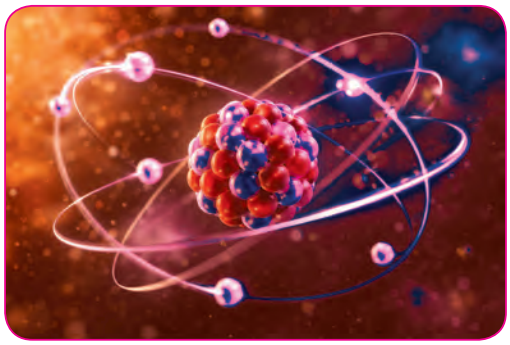

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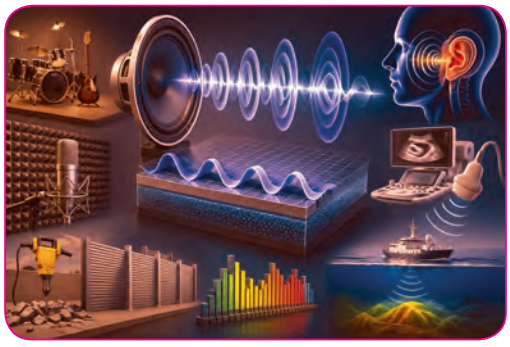

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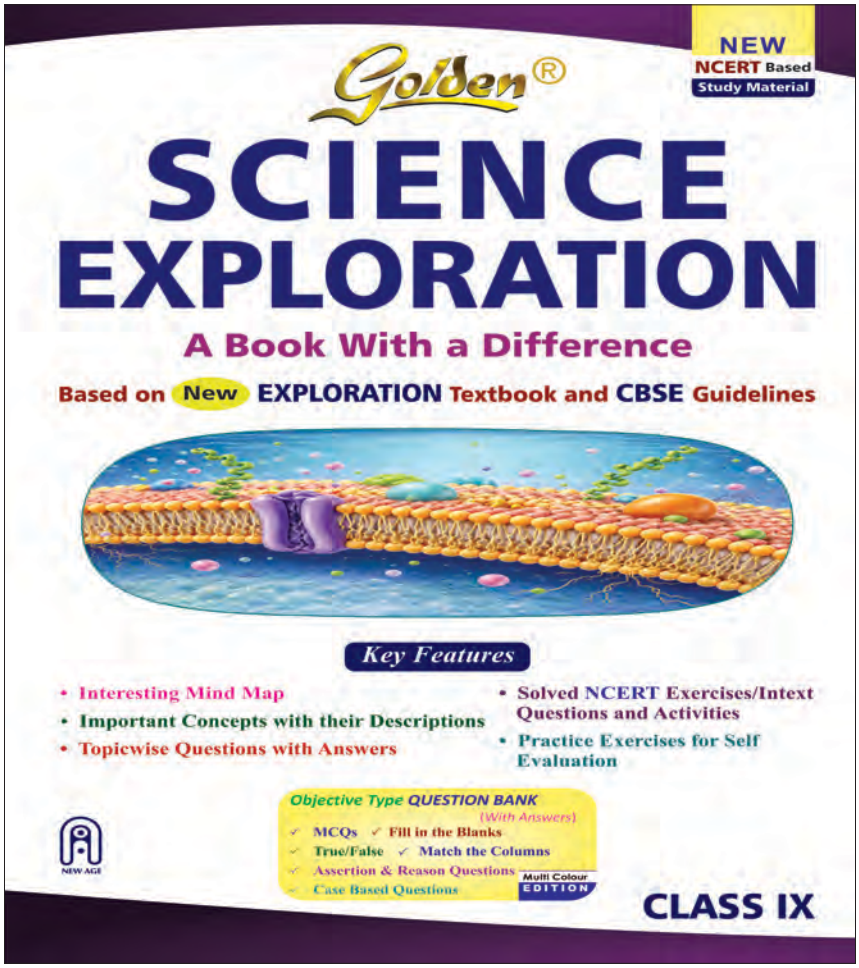

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Exploration: Entering the World of Secondary Science

1 Journey of Science

- Journey of science takes us to observe and measure the things around us.

2 Generation of ideas

- We note down our observations in the form of ideas.

3 Choice of models

- We choose appropriate models to understand the wonders of the world.

4 Building of models

- Models are built by making certain assumptions for the exploration of the world.

5 Law

- A law is a way to describe a regular pattern of nature.

6 Theory

- It explains the occurrence of patterns in nature.

7 Principles

- They help us to comprehend the situations.

8 Strength of science

- Science has power to predict the possible events.

9 What is science?

- Science is a human activity consisting of curiosity, creativity, collaboration and careful questioning.

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1 Exploration: Entering the World of Secondary Science

1.1 Entering the World of Secondary Science

- Science involves curiosity, observation, questioning, and experimentation.
- Science focuses on both what we know and how we know it.
- Science shows how observations are transformed into measurements, and how recurring patterns are represented through symbols and equations.
- Scientific ideas are tested, revised, and sometimes discarded.
- In science, models are used to represent complex systems and are continuously improved.
- Science helps us understand nature, technology, and our place in the world.

- **Exploration** in science requires careful observation direction in selecting appropriate models, asking the right questions and understanding the boundaries of each idea and purpose.

1.2 Models in Science

- The natural world is complex, so science uses **models** to simplify the reality.
- These models focus on only important details and ignore less relevant ones.
- Building a specific model involves making assumptions and deliberately ignoring certain factors.
- Ignoring details is not a mistake, but done to simplify understanding, making sure we get answers to what we are searching for.

1.3 Scientific Language and Mathematics

- Science uses precise and specific language.
- Everyday words (force, work, cell) have special meanings in science.
- Use of maths in science is as it expresses relationships clearly and is a language of understanding, not just calculation.
- **Scientific quantities** are represented using **symbols** and **units**.
- For instance, mass, velocity, force and electric current are represented using symbols like m, v, F and I.
- Science often uses mathematics to facilitate relationships between quantities to be expressed clearly.

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- Science employs mathematical expressions to describe the rates of chemical reactions, patterns of population growth, and changes in energy within a system.
- To apply mathematics in science, we must first analyse the situation, identify relevant quantities, and use mathematical relationships to reason carefully.

1.4 Importance of Units

- Standard units (SI units) ensure consistency worldwide, avoiding conversions and errors.

- Using wrong units can cause serious errors.
- ***Example:*** A passenger aircraft's fuel miscalculation due to unit confusion.

1.5 Laws, Theories, and Principles

- **Law:** Describes patterns observed in nature and is described by words or mathematical relationships.
- **Theory:** Explains why those patterns occur. These explanations are shaped by evidence gathered over time.
- ***For Example:*** The atomic theory helps us understand the fundamental of molecules, formation.
- **Principle:** Broad ideas guiding understanding.
- **For instance:** The principle of conservation of Energy applies when we climb up stairs.
- Scientific knowledge is based on evidence and can change with new findings.
- Scientific theories are not mere guesses; they involve rigorous testing and critical explanation.
- These theories and ideas remain open to improvement and often evolve as new evidence emerges.
- This improvement makes science more reliable.

1.6 Scientific Predictions

- Science allows prediction of outcomes.
- **Predictions** are based on evidence and not guesses.
- If predictions fail, models, measurements and assumptions are re-examined.

1.7 Nature of Science

- Science is not absolute.
- It improves with the appearance of new evidence.
- Science treats failure of models as its greatest strength, not weakness.
- When predictions do not match evidence, scientists do not discard ideas based on opinion—they rely solely on evidence.
- Scientific theories are never final—they can always be questioned and refined.

1.8 Estimation in Science

- Approximate answers are often sufficient, specifically in the early stages of reasoning.
- Estimation helps in checking reasonableness and building intuition.
- Exact values are not always necessary.
- The knowledge of estimation also helps us identify errors and enhance confidence in our thinking.
- Science consistently upholds the principle of critical (careful) reasoning over accurate calculations.

1.9 Science and Real Life

- Science connects multiple disciplines:
  - Physics
  - Chemistry
  - Biology
  - Earth science
- Almost every real-world problem require interdisciplinary thinking.
- Science naturally intersects with mathematics, technology, arts and social science.
- To fully understand the world, we must cultivate diverse ways of gaining insight and expressing ideas.

1.10 Scientific Thinking

- Science is a human activity involving:
  - Curiosity
  - Creativity
  - Collaboration
  - Critical Questioning
- It encourages scientists for critical thinking and learn from mistakes.
- It also helps understand **technology.**

KEY TERMS

1. **Assumption:** A condition accepted as true to simplify study.
2. **Estimation:** An approximate calculation to check reasonableness.
3. **Model:** A simplified representation of a system focusing on important features.
4. **Prediction:** A reasoned expectation based on evidence.
5. **Principle:** A general idea used to understand situations.
6. **Scientific law:** A statement describing a consistent pattern in nature.
7. **Scientific theory:** An explanation of why phenomena occur.
8. **SI Units:** Standard international units of measurement.

THINK IT OVER!

Q. 1. ***A cricket shot. Think of a cricket ball being hit for a six. You want to make a simple model. What details would you include? What would you ignore?*** ***(Page 2)***

Ans. To model whether a cricket ball will cross the boundary, we focus on key factors like its mass, speed, and direction, while ignoring irrelevant details like bat brand or ball colour. Smaller effects such as air resistance and spin can be neglected in a simple model but added later for greater accuracy.

Q. 2. ***How do we check predictions? Varsha told her friend Meghna, "It will rain this afternoon because the clouds look dark". Think of some questions Meghna could ask Varsha to make this prediction scientifically testable.*** ***(Page 4)***

Ans. Good scientific questions focus on measurable evidence and past patterns rather than simple yes/no type of answers. Meghna could ask about humidity, wind, temperature, and previous conditions when it rained to make the prediction testable.

Q. 3. ***Estimate how many litres of air you breathe in one day. Start by estimating how many breaths you take per minute, and the volume of one breath. Your aim is not to find an exact answer, but a reasonable estimate.*** ***(Page 6)***

Ans.

1. Estimating Breaths per day

- Breathing Rate (at rest) 12–15 breaths per minute

  Minutes in a day

  $60 \times 24 = 1440$ minutes
- Total breaths

  Multiplying the rate by the total minutes gives roughly = $(12 - 15) \times 1440 = (17280 - 21600)$ 18,000 to 22,000 breaths per day (rounded to approximately 20,000 for the estimation).

2. Estimating volume per breath

It takes about 4–5 breaths to fill a standard party balloon.

Balloon volume: Approximately 2 litres

Calculation: 2 litres ÷ 4 breaths

= 0.5 litre per breaths.

3. Now to find the total daily volume, multiply the total no. of breaths by the volume per breath.

= 2, 000 breaths × 0.5 litre/ breath

= 10, 000 litres of air per day.

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PAUSE AND PONDER

Q. 1. ***Think of a prediction you or your family made recently (for example, the outcome of a cricket match). Was it based on evidence and reasoning, or mainly on guesswork? How can scientific thinking improve such predictions?*** ***(Page 4)***

Ans. Recently my family was trying to predict rain by looking at dark clouds. The prediction was partly based on observation. However, accurate prediction involves scientific data such as humidity, temperature, wind speed, and past weather patterns. It concludes that scientific thinking improves predictions by relying on measurable evidence rather than assumptions.

Q. 2. ***Describe one situation where an approximate answer is good enough, and one where you would need a very exact value.*** ***(Page 6)***

Ans. An approximate answer is enough when estimating travel time (e.g., "about 30 minutes") or daily needs like food quantity. An exact value is needed in situations like measuring medicine doses or constructing a bridge, where precision is crucial for safety and correctness.

Q. 3. ***Choose a real-life object (maybe a pressure cooker or a mobile phone) or a problem (maybe a traffic jam near your school). Make a sketch listing what kind of ideas from physics, chemistry, biology, earth science, or mathematics are involved. Show how at least two branches of science connect with your example.*** ***(Page 6)***

Ans. **A pressure cooker** is a perfect mix of science. **Physics** is the main part—it traps steam to increase pressure, which raises the boiling point of water so food cooks faster. This connects directly to **Biology**, as the intense heat breaks down tough plant fibers and kills harmful bacteria, making the meal safe and easy to digest. **Chemistry** also plays a role through the Maillard reaction, which browns the food and creates rich flavours at these high temperatures.

GREAT SCIENTIST

Meghnad Saha (1893–1956) was a pioneering Indian astrophysicist best known for developing the Saha Ionisation Equation. Meghnad Saha's genius was in **simplifying the stars**. Instead of trying to capture every microscopic detail of stellar physics, he treated stars as **hot gases** and focused on just a few key variables: temperature, pressure, and ionisation of atoms. This approach led to the Saha Ionisation Equation, which explained why stars of different temperatures shine in different colours.

And yes, India honoured him with a **postage stamp** — a fitting tribute to a scientist whose work connected the light of distant stars to the physics of atoms here on Earth.

EXAM ORIENTED QUESTIONS

Very Short Answer Type Questions

Q. 1. ***What is meant by observation in science?***

Ans. In science, observation means careful noticing and recording of events or phenomena.

Q. 2. ***Define a scientific model.***

Ans. A scientific model is a simplified representation of a real system focusing on key aspects.

4. *What happens when predictions do not match observations?*

(*a*) They are ignored
(*b*) They are accepted anyway
(*c*) Models are re-examined
(*d*) Experiments are stopped

5. *Why are SI units used globally?*

(*a*) To increase calculations
(*b*) To avoid misunderstandings
(*c*) To reduce experiments
(*d*) To change results

• evidence • law • assumption
• estimations • relationships

(*i*) *Scientific models are built using _____ and simplifications.*

(*ii*) *A _____ describes a regular pattern observed in nature.*

(*iii*) *Mathematics helps express _____ between quantities.*

(*iv*) *Scientific knowledge improves with new _____.*

(*v*) *Rough calculations used to check answers are called _____.*

State whether the statements given below are True or False:

(*i*) *Scientific models always include every detail of a system.*

(*ii*) *Predictions in science are based only on guesswork.*

(*iii*) *Scientific ideas can change when new information is discovered.*

(*iv*) *Standard units help scientists communicate effectively.*

(*v*) *Mathematics in science is only useful for calculations.*

Match the Columns:

Match the following items given in Column A with that in Column B:

	Column A		Column B
1.	Model building	(*d*)	Measure quantities accurately
2.	Symbols	(*c*)	Changes with new evidence
3.	Scientific knowledge	(*b*)	Represent physical quantities
4.	Units	(*a*)	Ignoring less important details

Assertion-Reason Questions:

Directions: *For Questions number (i) to (ii), two statements are given — one labelled as Assertion (A) and the other labelled as Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.*

(*a*) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).

(*b*) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of Assertion (A).

(*c*) Assertion (A) is true, but Reason (R) is false.

(*d*) Assertion (A) is false, but Reason (R) is true.

(*i*) **Assertion (A):** Models are used to study real-world systems.
Reason (R): Real systems are often too complex to study fully.

(*ii*) **Assertion (A):** Scientific predictions are always accurate.
Reason (R): Predictions depend on assumptions and models.

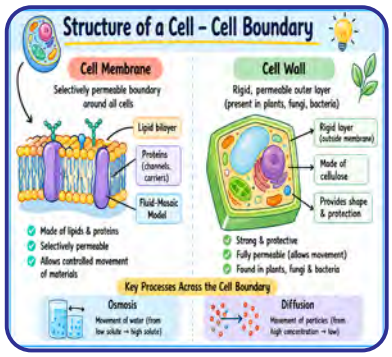
Scan for Answers

1 Study of Cells

- Robert Hooke (1665): rst observed cells in cork
- Light microscope: uses visible light
- Electron microscope: uses electrons

2 Structure of a Cell - Cell Boundary

- Cell Membrane: Selectively permeable, lipid bilayer and proteins (Fluid-Mosaic Model) (Osmosis, Diffusion)
- Cell Wall: Rigid, permeable, made of cellulose (in plants, fungi, bacteria)



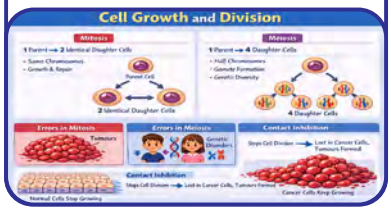
Cell: The Building Block of Life

3 Structure of the Cell - Cell Interior

- Prokaryotic: No well-defined nucleus, no membrane-bound organelles (e.g. Bacteria)
- Eukaryotic: Well-defined nucleus and membrane-bound organelles (e.g. Plant, Animal cells)
- Organelles: Sub-cellular components contained in cytoplasm
- Nucleus: DNA, chromosomes, genes; controls cell activities
- ER: RER (protein synthesis), SER (lipid/hormone synthesis)
- Golgi Apparatus: Packaging and sorting
- Lysosomes: Digestion of waste (clean-up system)
- Mitochondria: ATP production (powerhouse)
- Plastids: Chloroplast (green, photosynthesis), Chromoplast (coloured), Leucoplast (colourless, storage)
- Vacuole: Storage, turgor pressure

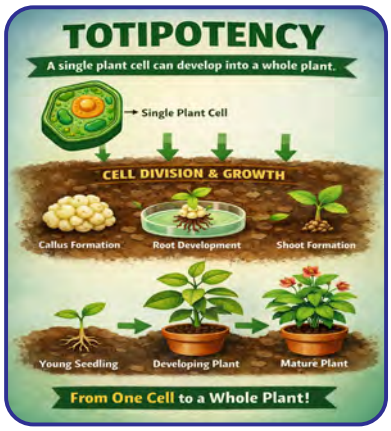
4 Cell Growth and Division

- Mitosis: 1 parent → 2 identical daughter cells (same chromosomes); growth and repair
- Meiosis: 1 parent → 4 daughter cells (half chromosomes); gamete formation; genetic diversity
- Errors in mitosis result in tumours
- Errors in meiosis result in genetic disorders
- Contact inhibition: Stops cell division; lost in cancer cells, tumours are formed



Cell Theory

- Schleiden (1838), Schwann (1839), Virchow (1855)
- All organisms are made of cells; cell is basic unit of life; cells arise from pre-existing cells.
- Totipotency: A single plant cell can develop into a whole plant.



2

Cell: The Building Block of Life

Introduction

- Scientific community accepts that life originated in water. **All living organisms are made up of cells.** The cell represents the basic level at which life exists.
- Some organisms, such as bacteria or yeast consist of only one cell **(unicellular)**, while others like plants, fish, birds or humans are made up of millions of cells **(multicellular)** that work together.
- A group of similar cells performing similar functions forms **tissues**. Different **tissues** are organised to form an **organ** and several organs work together to form **organ systems**.
- **Cell remains the fundamental unit of structure and function in all living organisms.**

2.1 How to Study Cells?

- A cell is usually too small to be seen by the unaided eye. **The human eye has a limit of resolution of 0.1 mm.** Two points closer than 0.1 mm appear as a single point when viewed from 25 cm. A convex lens or combination of lenses (objective lens and eyepiece) is used to magnify objects too small to be seen with the naked eye.
- **Robert Hooke** in 1665 was the **first to observe cells using a self-designed microscope** (200–300X magnification) while examining a thin slice of cork.
- Light microscope uses visible light and different objective lenses (10X, 40X) to achieve **magnification** and **resolution.**
- **Total magnification is the magnifying power of eyepiece multiplied by the magnifying power of objective lens.**

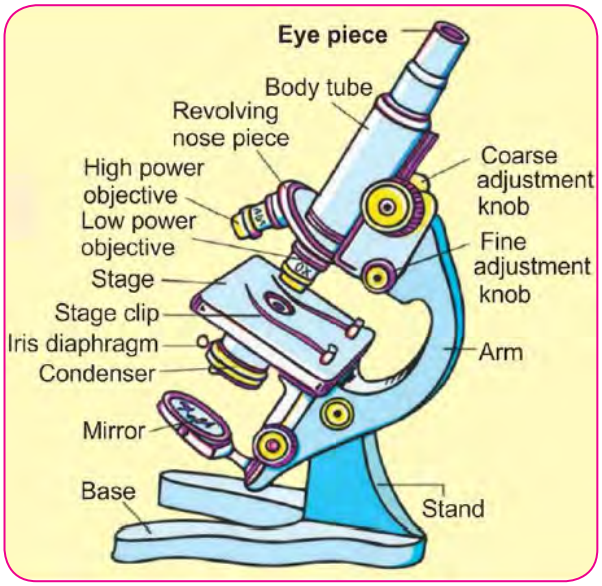


Fig. Light microscope

- **Electron microscope uses a beam of electrons** instead of light to produce highly magnified images at the nanometre scale.

Fig. Electron microscope

- Over the years, scientists have improved the microscope by improving its three main features e.g. **resolution** (measure of clarity), **contrast** (the difference in brightness between various parts of an object), and **magnification** which resulted in making microscope a powerful tool for studying cells.

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2.2 Structure of a Cell

- Cells are organised into specialised tissues and organs, and collectively perform specific function. For these cells to function as units, they must be able to interact with one another and with their surroundings.

2.2.1 Cell Membrane—The Universal Feature of a Cell

- Universal feature of a cell is its cell membrane (plasma membrane). It is a thin, **selectively permeable** boundary (7–10 nm thick) surrounding all cells. It allows some substances to pass through while blocking others.
- **The movement of water through a selectively permeable membrane from a region of higher water concentration to a region of lower water concentration is called osmosis.**
- Net movement of particles from higher to lower concentration, even without a membrane is called **diffusion**. Osmosis is the **diffusion** of water across a selectively permeable membrane. In plants, water from the soil enters root cells by the process of osmosis.
- In **isotonic solution**, the solute concentration outside the cell equals solute concentration inside the cell. In **hypotonic solution**, solute concentration outside the cell is less than inside the cell; water enters the cell. In **hypertonic solution**, solute concentration outside the cell is greater than inside the cell; water leaves the cell.
- **Fluid-mosaic model** explains the structure of the cell membrane as a lipid bilayer with embedded proteins which act like gatekeepers in helping substances pass through. The molecules can move, making it **fluid**. Protein molecules are arranged like tiles in a **mosaic**. Hence it is called **mosaic model**.

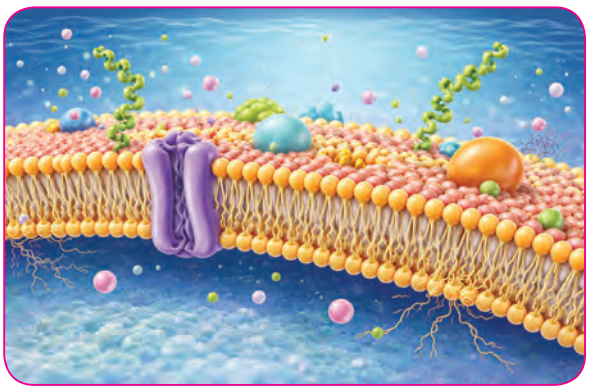

Fig. Fluid-mosaic model of bio membrane (after Singer and Nicolson, 1972)

2.2.2 Cell Wall—The Outer Covering of Cells

- All living cells communicate with their surroundings and their neighbouring cells through the cell membrane. However, cells of plant, fungi, and bacteria have an additional layer around the cell membrane, called the **cell wall**.
- **The cell wall is an additional rigid covering outside the cell membrane found in plant cells, fungi, and bacteria.** It is made mainly of cellulose in plants. It is permeable and provides shape, strength, and rigidity.
- **Animal cells lack a cell wall**, so they can change shape easily, supporting movement and tissue function.

2.3 The Cell Interior — A Coordinated Working System

- **Plasma membrane, cytoplasm,** and **nucleus** are the three basic parts of most cells. **Plasma membrane is selectively permeable membrane**. Cytoplasm is a semi-fluid jelly like substance.

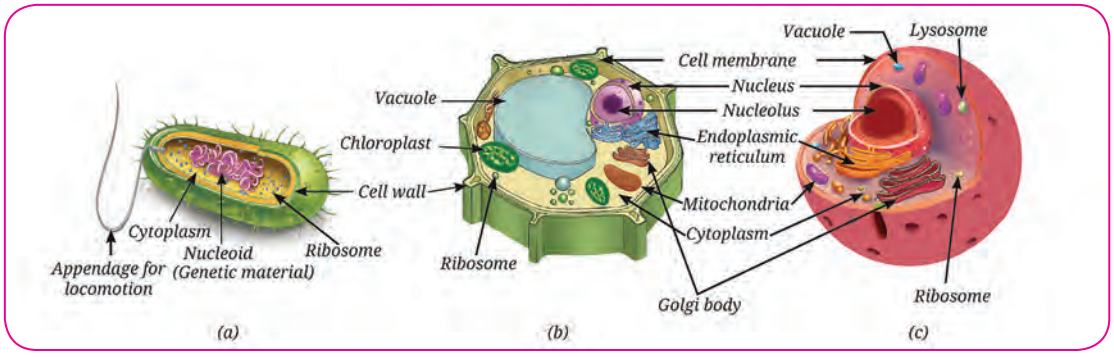

Fig. (a) A typical bacterial cell, (b) a typical plant cell, and (c) a typical animal cell

- In addition to the prominent nucleus, the cytoplasm contains several sub-cellular components called **organelles**, along with other substances present in it, most of which are only visible with an electron microscope.
- **Prokaryotic** (*pro* means primitive and *karyon* means nucleus) **cells** lack a well-defined nucleus and membrane-bound organelles. ***Example:*** bacteria.

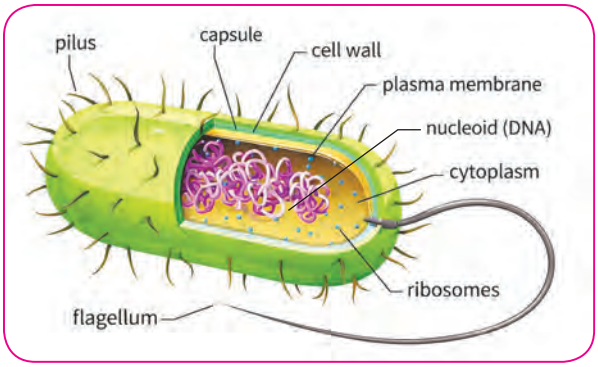

Fig. Prokaryotic Cell

- **Eukaryotic** (*eu* means true, and *karyon* means nucleus) **cells** have a well-defined nucleus and membrane-bound organelles. ***Example:*** plant and animal cells. In eukaryotic cells, a network of fine fibres forms the **cytoskeleton**, which provides structural support, maintains cell shape, and enables cell movement and internal transport. Eukaryotic cells carry out various life processes in different cell organelles independently at the same time.
- **Viruses are a cellular** (no cells) infectious agents that are too small to be seen under a light microscope. Viruses are composed of some genetic material with a protein coat.
- Cell organelles help in building new materials, removing waste, and providing energy to the cell. They work together to perform all functions of a cell. Thus, **a cell is like a tiny living factory**, with each of its parts performing a specific job.

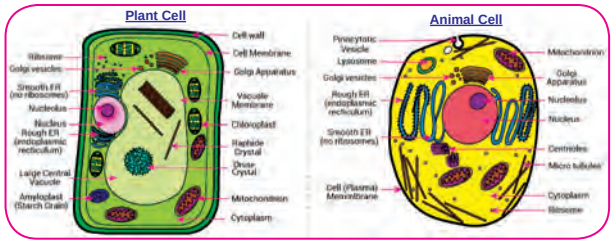

Fig. Eukaryotic Cells— (A) Cell structure of Typical Plant Cell (B) Cell structure of Typical Animal Cell

2.3.1 Why do Eukaryotic Cells need these Organelles?

- **Nucleus** has a double-layered nuclear membrane with pores. It contains **chromosomes** (DNA+ proteins). DNA carries genetic information. Functional segments of DNA are called **genes**.
- Some cells are specialised to perform specific functions. ***For example,*** mature **Red Blood Cells (RBCs) in humans do not have a nucleus** (enucleate). The absence of a nucleus provides more space for haemoglobin, allowing it to transport a larger amount of oxygen to all cells of the body. Since they lack a nucleus, they cannot repair or divide themselves. As a result, their lifespan is short and they survive approximately for 120 days. The sieve cells in phloem are also enucleated.

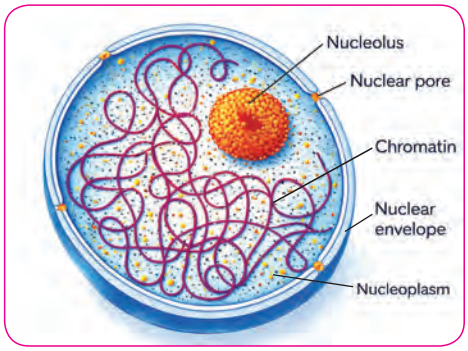

Fig. Structure of Nucleus

- Prokaryotic cells do not have a well-defined nucleus. Their DNA is present as a single circular molecule associated with specific proteins. The region containing this genetic material is called the **nucleoid.**
- **Ribosomes** are the tiny structures that are **sites of protein synthesis**, found freely in cytoplasm or attached to the **Endoplasmic Reticulum** (ER).

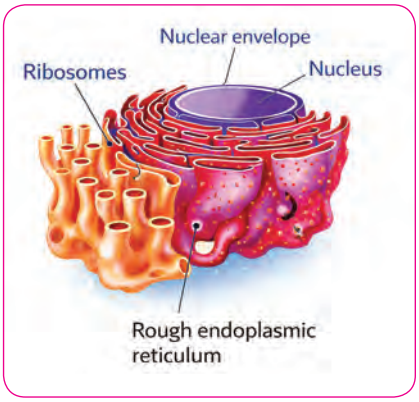

Fig. Structure of Endoplasmic Reticulum

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- **Endoplasmic Reticulum (ER)** is a large organelle which spreads like a network within the cytoplasm. **Rough Endoplasmic Reticulum has ribosomes (protein synthesis)** while **Smooth Endoplasmic Reticulum lacks ribosomes (lipid and hormone synthesis).**
- **Golgi apparatus** has stacks of flattened sacs that modify, sort, and help in package of proteins and lipids for transport, secretion, or lysosome formation. **It acts like the cell's post office**.

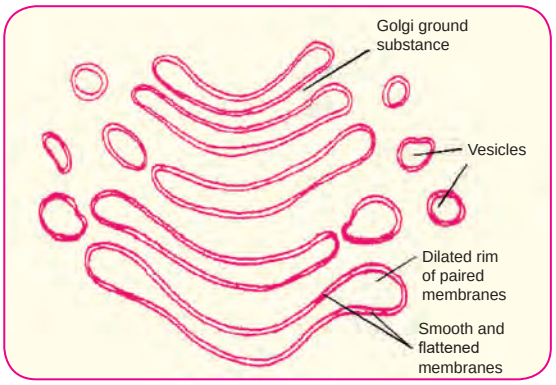


Fig. Structure of Golgi Apparatus

- **Lysosomes are single membrane-bound sacs** filled with enzymes that break down waste materials and damaged organelles. Human sperm cells contain lysosomal enzymes. When a sperm meets an egg, these enzymes help break down the outer layer of the egg, allowing fertilisation to take place.
- **Mitochondria** are double-membrane organelle; the inner membrane has folds called **cristae which increase the surface area for chemical reaction and facilitate energy production.** Mitochondria break down glucose to release energy that is stored as ATP (energy currency of the cell). These are called the **powerhouse of the cell**.

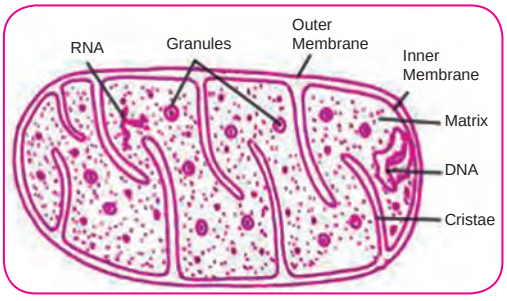


Fig. Internal Structure of Mitochondria

- **Plastids** are found in plant cells. These are of three types: **Chloroplast**s are green in colour and help in photosynthesis, **Chromoplasts** are coloured and attract pollinators, **Leucoplasts** are colourless and store food.
- Inside the chloroplasts, there is a semi-fluid substance matrix, called the **stroma**. Stroma are disc shaped membrane structures that contain **chlorophyll** which absorbs sunlight during photosynthesis. Stroma stores the sugar synthesised during photosynthesis.
- **Mitochondria** and **plastids** have some features that are similar to certain bacteria. For example, they **both have their own DNA and ribosomes**, and thus, they can make some of their own proteins. These characteristics suggest that both mitochondria and plastids share an evolutionary history with these single-celled organisms.

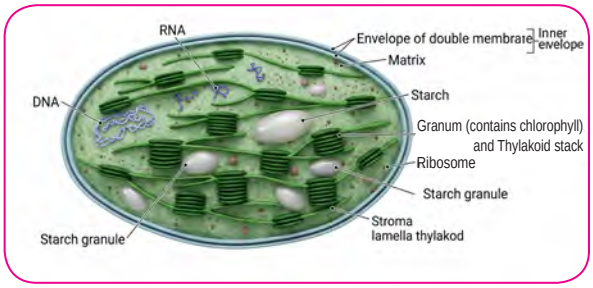


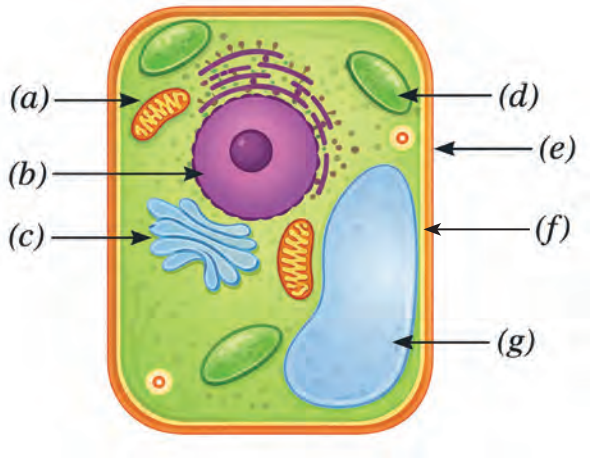
Fig. Internal Structure of Chloroplast

- In a mature plant cell, there is one large central vacuole which is filled with watery fluid called **cell sap**. The membrane of the central vacuole is called **tonoplast**. The vacuole stores water, minerals, sugar and waste material and thus helps maintain pressure inside the cell, thereby keeping the plant cell firm (turgid). When a plant does not get enough water the vacuole loses water, the cells become less firm, and the plant gets wilted. In animal cells vacuoles are small.

2.4 How do Normal Cells Grow and Divide?

- In 2010, scientist **J. Craig Venter** and his team made an important discovery in the field of synthetic biology. They first **studied the complete DNA sequence** of a simple bacterium called **Mycoplasma mycoides** using computer programming. Then, they chemically synthesised (in the laboratory) an exact copy of this DNA. They also performed an experiment to show that DNA controls the structure and activities of the cell.

Q. 3. ***Look at the diagram of a cell in Fig. Identify the parts labelled from (a) to (g) and correctly match them with their functions given below:***



(*i*) ***Controlling all the activities of a cell.***

(*ii*) ***Site of cellular respiration.***

(*iii*) ***Storage organelle that also provides rigidity to the cell.***

(*iv*) ***Separates the cell contents from surroundings.***

(*v*) ***Provides structural rigidity to the cell.***

(*vi*) ***Packs and stores materials received from ER.***

(*vii*) ***Helps in manufacturing food.***

Ans. Identifying parts labelled (a) to (g) and matching with functions:

(*a*) **Mitochondria:** (ii) Site of cellular respiration.

(*b*) **Nucleus:** (i) Controlling all the activities of a cell.

(*c*) **Golgi apparatus:** (vi) Packs and stores materials received from ER.

(*d*) **Chloroplast:** (vii) Helps in manufacturing food.

(*e*) **Cell wall:** (v) Provides structural rigidity to the cell.

(*f*) **Cell membrane:** (iv) Separates the cell contents from surroundings.

(*g*) **Vacuole:** (iii) Storage organelle that also provides rigidity to the cell.

Q. 4. ***Which of the following option(s) of the pairs of cell organelles are correctly placed under the given categories?***

Option	Present in Plant cells	Absent in animal cells
(*i*)	Leucoplast	Cell wall
(*ii*)	Mitochondria	Ribosome
(*iii*)	Cell wall	Golgi apparatus
(*iv*)	Lysosome	Endoplasmic reticulum

Ans. Option (*i*) is correct. Leucoplast is present in plant cells and cell wall is absent in animal cells.

Q. 5. ***Two students, Renu and Rohit, were having a discussion on the plastids. Renu emphasised that all parts of the plants, even roots, contain plastids. However, Rohit did not agree with the statement and told her that plastids are absent in plant roots since the roots are underground and do not need to perform photosynthesis. Who is correct? Justify your answer.***

Ans. Renu is correct. All parts of plants, including roots, contain plastids. **Roots contain leucoplasts,** which are colourless plastids that store food materials like starch. **Not all plastids carry out photosynthesis.** While chloroplasts (found mainly in green parts like leaves) carry out photosynthesis, **leucoplasts in roots store starch** and other food materials. Potato tubers, which are underground stems, store starch in leucoplasts.

Q. 6. ***Mitochondria and chloroplasts are two important organelles in a plant cell. Discuss how these two organelles are structurally and functionally similar to each other, and different from each other.***

Ans. Similarities between Mitochondria and chloroplasts:

- Both are double-membrane organelles.
- **Both contain their own DNA and ribosomes** and can make some of their own proteins.
- Both are involved in energy-related processes.

Differences between Mitochondria and chloroplasts:

- **Mitochondria break down glucose to release energy** (cellular respiration) and produce ATP. They are found in both plant and animal cells.
- **Chloroplasts capture solar energy** and use it to synthesise food (photosynthesis). They contain the green pigment chlorophyll. Chloroplasts are found only in plant cells.

Q. 7. ***Which of the following pairs of cell organelles contains DNA?***

(*i*) ***Chloroplasts, Ribosomes***

(*ii*) ***Mitochondria, Nucleus***

(*iii*) ***Golgi bodies, Ribosomes***

(*iv*) ***Nucleus, Lysosomes***

Ans. (*ii*) Mitochondria, Nucleus. Both mitochondria and the nucleus contain DNA. Ribosomes, Golgi bodies, and lysosomes do not contain DNA.

Q. 8. ***A researcher carried out an experiment in which she took two carrots of similar size. She placed one carrot in plain water and the other carrot in concentrated salt solution (Fig. below). After 24 hours she recorded her observations.***

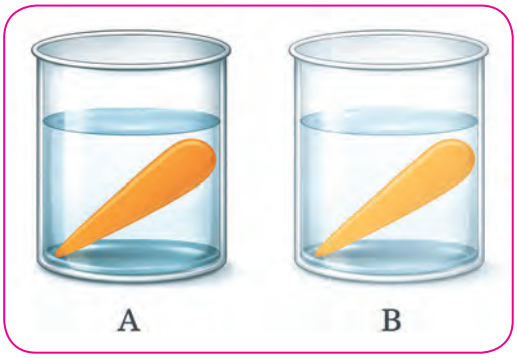


Fig. Experimental set-up having carrot (a) in plain water, and (b) in salt solution

(*i*) ***What hypothesis does she want to test through this experiment?***

(*ii*) ***What would you suggest for the improvement of this experiment?***

(*iii*) ***Why does the carrot in plain water stay stiff and crunchy, but the carrot in concentrated salt solution becomes rubbery and limp?***

Ans. (*i*) The hypothesis is that a selectively permeable cell membrane allows the movement of water in and out of cells by osmosis, depending on the concentration of the surrounding solution.

(*ii*) To improve the experiment, the researcher should repeat it multiple times with carrots of the same size, and measure the initial and final weights of the carrots for more reliable results.

(*iii*) The **carrot in plain water stays stiff and crunchy because water enters its cells by osmosis**, keeping the cells firm (turgid). The carrot in concentrated salt solution becomes rubbery and limp because water moves out of its cells by osmosis, causing the cells to lose their firmness.

Q. 9. ***Indicate the presence or absence of following structures in bacterial and animal cells:***

Structures in a cell	Bacterial Cell	Animal Cell
Chromosome		
Nucleus		
Mitochondria		
Golgi complex		
Chromoplasts		

Ans.

Structures in a Cell	Bacterial Cell	Animal Cell
Chromosome	Absent (has nucleoid)	Present
Nucleus	Absent	Present
Mitochondria	Absent	Present
Golgi complex	Absent	Present
Chromoplasts	Absent	Present

Q. 10. ***Carry out the following experiment:***

Take four peeled potato halves and scoop each one out to make potato cups. One of these potato cups should be made from a boiled potato. Place each of the potato cups in a beaker containing water (Fig. below).

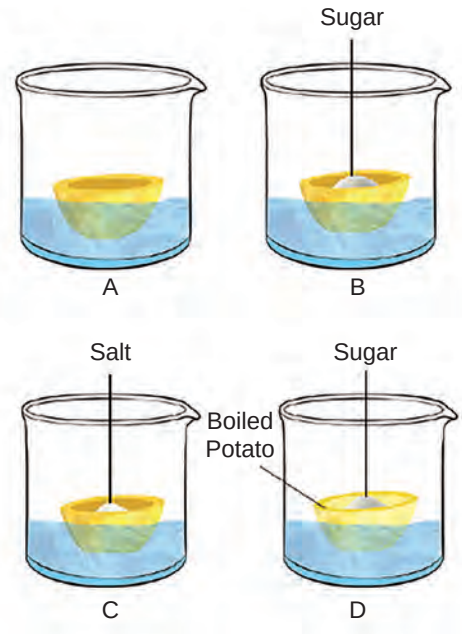


Fig. Experimental set-up

Now, set up the experiment as follows:

(*a*) Keep Cup A empty.

(*b*) Add one teaspoon sugar in Cup B.

(*c*) Add one teaspoon salt in Cup C.

(*d*) Add one teaspoon sugar in the boiled potato in Cup D.

Observe the four potato cups at least two hours and answer the following questions:

(*i*) ***Explain why water gathers in the hollowed portion of Cup B and Cup C.***

(*ii*) ***Why is Cup A necessary for this experiment?***

(*iii*) ***Explain why water does not gather in the hollowed portions of Cups A and D.***

Ans. Potato cup experiment:

(*i*) **Water gathers in the hollowed portions of Cup B and Cup C because sugar and salt in the cups create a hypertonic solution**. Water from the surrounding potato cells moves into the cup through the selectively permeable cell membranes of the potato cells by osmosis.

(*ii*) Cup A is necessary as a control in the experiment. Since it has no sugar or salt, it shows that water does not gather in the cup on its own, proving that the water collection in Cups B and C is due to osmosis.

(*iii*) **Cup A has no solute, so there is no osmosis**. **In Cup D, the boiled potato's cells are dead** and their cell membranes are destroyed, so osmosis cannot occur.

Q. 11. ***Identify the pair that incorrectly matches the cell organelle with its function. (i) Ribosome — Protein synthesis (ii) SER — Lipid and cellulose synthesis (iii) Lysosome — Digestion of foreign agents***

Ans. (*ii*) SER and cellulose synthesis is the incorrect match. SER is involved in lipid and hormone synthesis, not cellulose synthesis.

Q. 12. ***What outcome do you expect, if all the mitochondria are removed from a eukaryotic cell?***

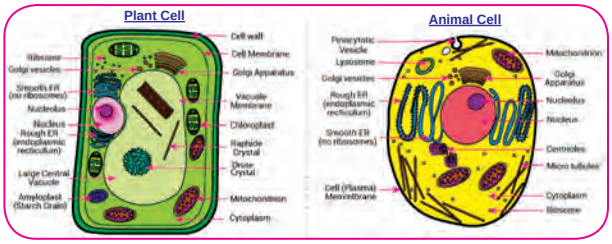
Ans. If all mitochondria are removed, the cell would not be able to carry out cellular respiration. It would not be able to break down glucose and produce ATP (energy currency). Without ATP, the cell would lack energy for all its activities and would finally die.

Q. 13. ***Which phenomenon inhibits the formation of tumours in the human body? Can plants also develop tumours? Explain.***

Ans.

- **Contact inhibition** is the phenomenon that inhibits the formation of tumours. In normal animal cells, cell division stops when cells come in contact with neighbouring cells.
- Cancer cells lose this property and keep dividing uncontrollably, forming tumours.
- Yes, plants can also develop tumours. However, since **plant cells have rigid cell walls, they do not show contact inhibition** and follow a different growth pattern.
- Plant tumours can be caused by certain bacteria or viruses.

Q. 14. ***The cell membrane of a cell is made up of proteins and lipids. Which cell organelles help in the synthesis of cell membrane? Write the path of these compounds from their site of synthesis to the cell membrane and show this through a labelled diagram.***



Ans.

- **Proteins** for the cell membrane are synthesised by the **Rough Endoplasmic Reticulum** (RER), and **lipids** are synthesised by the **Smooth Endoplasmic Reticulum** (SER).

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GREAT SCIENTISTS

1. **Robert Hooke:** Cell was first identified by **Robert Hooke (1665).** While examining a thin slice of cork under his primitive microscope, he noticed tiny box-like compartments. He named them **cellulae** (singular—**cellula**). In Latin, *cella* means a small chamber or compartment, from which the word **cell** is derived.

2. **Anton Von Leeuwenhoek:** In **1674, Anton Von Leeuwenhoek,** a Dutch microscopist, developed an improved microscope. With its help, he became the first to observe **free-living microorganisms in pond water.** Later, in **1678**, he also discovered **sperm cells**.

3. **Camillo Golgi:** The Italian scientist **Camillo Golgi** discovered the **Golgi apparatus** in 1898, while studying the nerve cells of a barn owl. Using a special staining method, he observed a thread-like network. Early microscopes could not clearly resolve it, so many scientists doubted its existence. However, later observations through the **electron microscope** confirmed its presence. Once its structure was clearly seen and verified, it was named the **Golgi apparatus in his honour.**

4. **Gottlieb Haberlandt:** In **1902,** Austrian botanist **Gottlieb Haberlandt** proposed that **any living plant cell**, even a fully mature cell from a permanent tissue, could grow into a complete plant if supplied with proper nutrients and favourable conditions. He suggested that plant cells possess the ability to form different kinds of cells and also alter them. **This property is known as totipotency**. Haberlandt's idea became the basis for a new branch of biology called **Plant Tissue Culture Technology.**

5. **Arun Kumar Sharma (1924–2017): Arun Kumar Sharma** was a distinguished Indian scientist known for his research on **chromosomes.** He also made notable contributions in the fields of **plant taxonomy, evolution,** and **development**. As a botanist, he developed several useful methods for studying plant chromosomes. He received many honours, including the **Shanti Swarup Bhatnagar Award** and the **Padma Bhushan** for his outstanding work in botany.

6. **J. Craig Venter:** Scientist **J. Craig Venter** and his team made a major advancement in the field of **synthetic biology in 2010.** They first analysed the complete DNA sequence of a simple bacterium called Mycoplasma mycoides using computer programming. After that, they chemically synthesized an exact copy of this DNA in the laboratory.

7. **Matthias Schleiden, Theodor Schwann and Rudolf Virchow:** In **1838,** German botanist **Matthias Schleiden** stated that all plants are made up of cells. In **1839,** German zoologist **Theodor Schwann** found that all animals are also composed of cells. Later, in **1855,** German scientist **Rudolf Virchow** further expanded the **Cell Theory** by stating that new cells arise only from pre-existing cells.

Long Answer Type Questions

Q. 1. ***Describe the significance of the microscope in the study of cells. Mention three features of a microscope that have been improved over the years.***

Ans. The microscope is an essential tool for studying cells because cells are too small to be seen with the unaided eye. **Robert Hooke first observed cells** in 1665 using a **self-designed microscope**.

Since then, microscopes have become increasingly powerful. The three main features that have been improved over the years are:

(*i*) **Resolution**, **which is the measure of clarity** and the ability to distinguish two closely placed objects as separate.

(*ii*) **Contrast, which is the difference in brightness** between various parts of an object, making details more visible.

(*iii*) **Magnification, which is the ability to make objects appear larger**.

These improvements have made the microscope a powerful tool, from the light microscope used in school laboratories to the electron microscope that reveals structures at the nanometre scale.

Q. 2. ***Describe the fluid-mosaic model of the cell membrane. How does its structure help in the movement of substances?***

Ans.

- The **fluid-mosaic model** explains the structure of the cell membrane. According to this model, the cell membrane is made up of a **lipid bilayer** (two layers of fat molecules) with **proteins** embedded in them.

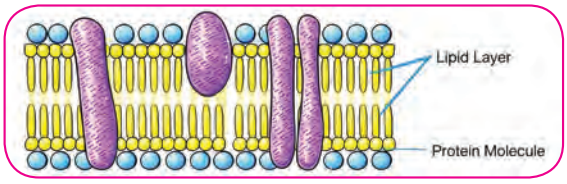


Fig. Fluid-mosaic model of bio membrane (after Singer and Nicolson, 1972)

- The fat molecules have water-attracting heads facing outwards and water-repelling tails facing inwards. The molecules can move making the membrane fluid.
- Proteins are scattered like tiles in a mosaic pattern.
- These proteins act as gatekeepers, helping substances pass through the membrane.
- Some proteins form channels that allow specific molecules to enter or exit the cell, while others help in transporting substances against the concentration gradient.

This **selective permeability of the cell membrane** is essential for maintaining the internal environment of the cell.

Q. 3. ***Describe the structure and functions of mitochondria. Why are they called the powerhouse of the cell?***

Ans. Mitochondria are double-membrane organelles found in almost all eukaryotic cells. The outer membrane is smooth and porous, while the inner membrane is folded into finger-like projections called **cristae**. The cristae increase the surface area for chemical reactions.

Inside the mitochondria, glucose and other molecules are broken down during **cellular respiration**. The energy released from this process is stored in the form of ATP (Adenosine Triphosphate), which is used for most cellular activities.

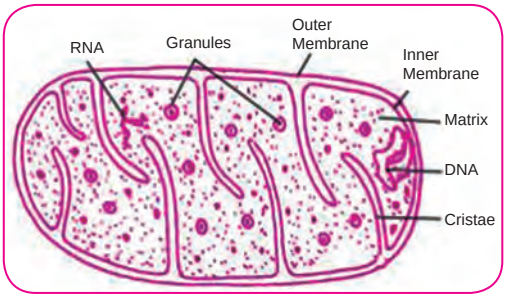


Fig. Internal Structure of Mitochondria

Since mitochondria supply the energy needed for most cellular processes, they are called the **powerhouse of the cell.**

Mitochondria have their own DNA and ribosomes, which allows them to make some of their own proteins.

Q. 4. ***Compare the structure of a plant cell and an animal cell (at least five differences).***

Ans.

	Plant cell	Animal cell
1.	The outermost covering of the plant cell is cell wall formed of cellulose. Cell wall is present outer to plasma membrane or cell membrane.	The outermost covering of the animal cell is plasma membrane. Cell wall is absent.
2.	Large central vacuole is present	Vacuoles are of small size or absent and temporary.
3.	Because of large central vacuole, cell organelles and nucleus lie towards the boundary wall or periphery of the cell.	Nucleus lies in the centre of the cell and other cell organelles also lie surrounding it.
4.	Plastids are present.	Plastids are absent.
5.	Centrioles are absent. Polar caps help in the formation of spindle apparatus during cell division.	Centrioles are present within the centrosome which help in the formation of spindle apparatus during cell division.
6.	Simple form of Golgi apparatus called dictyosome is present.	Golgi apparatus is single highly complex and prominent structure.

ACTIVITIES

Activity 2.1: Let us estimate the size of a cell *(Page 10)*

1. Take a transparent ruler with millimetre (mm) markings.
2. Place the ruler on the stage of microscope, focus on it using the adjustment knob and observe the diameter of the circular field of view through the eyepiece and measure it in mm.
3. Convert the diameter from mm to micrometre (µm). Suppose the diameter of the visible field is 5 mm, meaning 5 × 1000 = 5000 µm.
4. Remove the ruler and place an onion peel slide on the stage of the microscope.
5. Focus on the slide and count the number of cells present along the diameter of the field of view in one straight line.
6. **Estimate** the real size of the cell using the formula:

Unit conversion

1 millimetre (mm) = 1000 micrometre (µm)

Estimated size of the onion peel cell

$$= \frac{\text{Diameter of the visible field in micrometre}}{\text{Number of cells along the diameter}}$$

Ans. In this activity, students measure the diameter of the circular field of view of the microscope using a ruler. Suppose the diameter is 5 mm = 5000 µm.

After placing the onion peel slide, if 25 cells are counted along the diameter, the estimated size of one onion cell = $\frac{5000\ \mu m}{25}$ = **200 µm.**

If the eyepiece and objective lens are both 10X, then total magnification is 100X, meaning the 200 µm cell appears 100 times larger.

Activity 2.2: Let us experiment *(Page 11)*

1. With the help of a kitchen knife, carefully cut a potato into two pieces of roughly equal size (Fig.).
2. Measure and record the initial weight of both the pieces using a weighing balance.
3. Put one piece of the potato in Beaker A with plain water.
4. Put the other piece of the potato in Beaker B with 20 per cent salt or sugar solution.
5. Leave them undisturbed for about an hour or until you notice a visible change in the size of the pieces.
6. Measure and record the final weight of each piece.
7. Calculate the difference between the initial and their final weights.

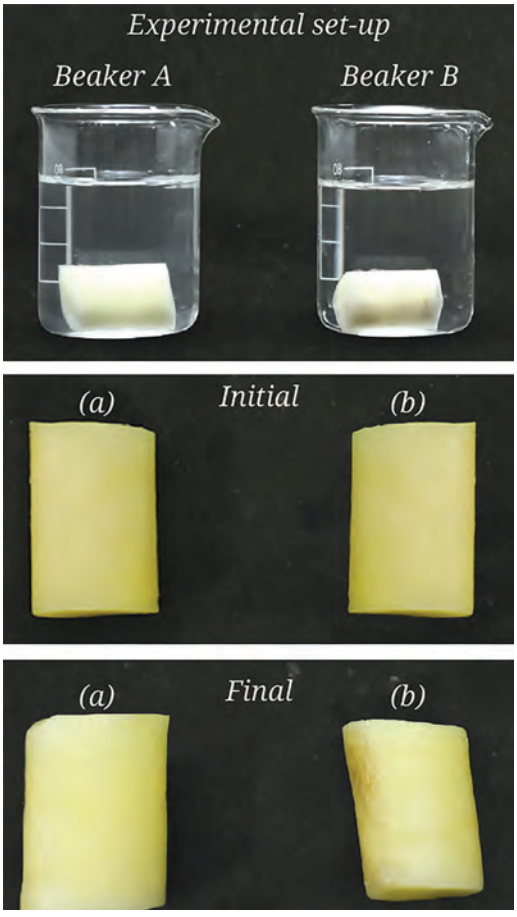
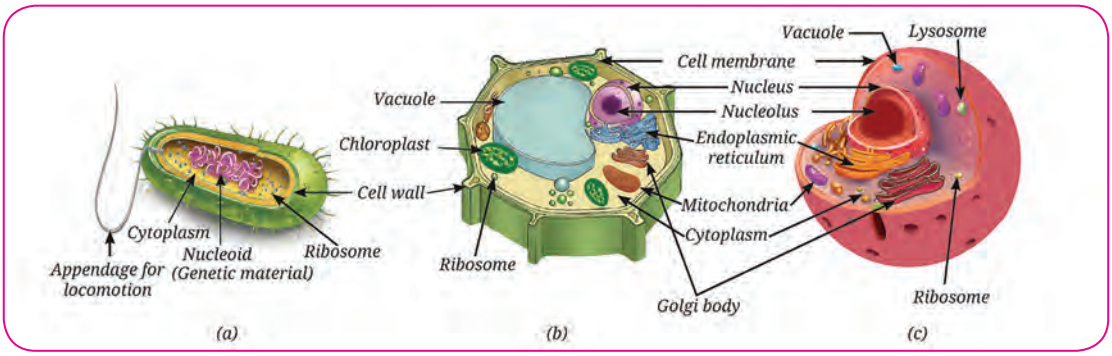


Fig. Experimental set-up, and initial and final states of potato pieces in (a) plain water, and (b) 20 per cent salt solution

Activity 2.4: Let us study *(Page 14)*



1. Study the given diagrams of a bacterial cell, a plant cell, and an animal cell.
2. Observe the different structures present in each of them.
3. Record your observations in the Table given below:

Table: Comparison of different kinds of cells based on their structure

S.No.	Cell structures	Bacterial cell	Plant cell	Animal cell
1.	Cell membrane			
2.	Cell wall			
3.	Cytoplasm			
4.	Well-defined nucleus (genetic material enclosed by a membrane)			
5.	Primitive nucleus (nucleoid) genetic material without membrane around it)			
6.	Membrane-bound organelles			

Ans. Observations to be recorded in the above Table are:

1. **Cell membrane** is present in all three types of cells.
2. **Cell wall** is present in bacterial and plant cells but absent in animal cells.
3. **Cytoplasm** is present in all three.
4. **Well-defined nucleus** is present in plant and animal cells but absent in bacterial cells.
5. **Primitive nucleus (nucleoid)** is present only in bacterial cells.
6. **Membrane**-bound organelles are present in plant and animal cells but absent in bacterial cells.

Table: Comparison between Prokaryotic and Eukaryotic cell based on their structure

Characteristics	Prokaryotic cell	Eukaryotic cell
Primitive nucleus	Present	Absent
Diameter of a typical cell	1 to 10 μn	10 to 100 μn
Number of cells in an organism	Usually unicellular	Can be unicellular or multicellular
Membrane-bound organelles	Absent	Present
Membrane-bound nucleus	Absent	Present

In prokaryotic cells, most cellular activities take place directly in the cytoplasm. In contrast, plant and animal cells have a well-defined nucleus and several membrane-bound organelles. Such cells are called **eukaryotic cells** (*eu* means true, and *karyon* means nucleus). More details of the characteristics of prokaryotic and eukaryotic cells are given in the Table given above.

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II. Which of the cells given in the Fig. fall under the categories of prokaryotic and eukaryotic cells?

Ans.:

- Bacterial cell is a prokaryotic cell.
- Plant and animal cells are eukaryotic cells.

Activity 2.5: Let us enhance our skills *(Page 20)*

1. Take a jar and fill it up with plain water.
2. Now, place an onion bulb over the jar in such a way that its base bearing roots is immersed in the water.
3. Leave the setup for 5–6 days and observe.

   Do you observe the roots growing?

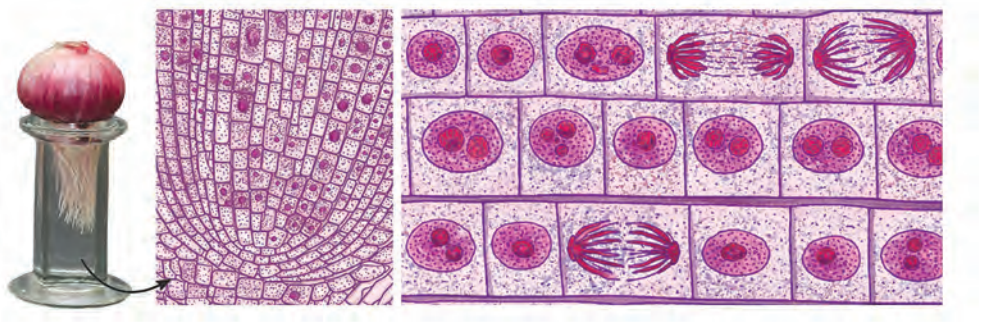

Fig.: Different stages of cell division in onion root tip cells

Ans. Yes, growth in roots is observed.

1. Cut 2–3 cm of the freshly grown roots and transfer them to freshly prepared aceto-alcohol (glacial acetic acid:ethanol :: 1:3).
2. Keep the root tips in aceto-alcohol for 24 hours.
3. Transfer them to 70 per cent ethanol (for preservation).
4. Take one or two preserved roots, wash them in water and then, place them on a clean slide.
5. Put one drop of dilute Hydrochloric acid (HCl) on the root tips to soften the tissue.

   Rinse the roots after 10–15 minutes. Then add 2–3 drops of aceto-carmine stain on them.
6. Leave the slide for 5–10 minutes and then, gently warm it (with caution) over a spirit lamp.
7. Cut the tip portion of the root on the slide and put a coverslip. Gently squash the coverslip with your thumb to spread the cells on the slide.
8. Observe the slide under a microscope.

   (*i*) What do you observe? Do you observe the cells of the onion root tip?

   (*ii*) Are they similar in structure?

   (*iii*) Do you find any structural differences in these cells? If yes, why is it so?

Ans.

(*i*) The cells of a growing tip of root of onion divide continuously. This process is called **cell division**.

(*ii*) The cells are not all similar because the growing **root tip cells divide continuously**.

(*iii*) (*a*) Under the microscope, the cells of the onion root tip show different structures because they are at different stages of cell division.

(*b*) Some cells show well-defined nuclei (interphase), while others show visible chromosomes at various stages of mitosis.

(*c*) These cells exhibit different structures corresponding to different stages of cell division.

EXERCISE FOR PRACTICE

Very Short Answer Type Questions

1. *Define diffusion.*
2. *What is the function of the nuclear membrane?*
3. *Name the plastid responsible for the red colour of tomatoes.*
4. *What are genes?*
5. *What is cell sap?*
6. *Name the scientist who proposed the Cell Theory about animals.*
7. *What type of cell division forms gametes?*
8. *What is the function of cristae in mitochondria?*
9. *What is cell culture?*

Short Answer Type Questions

1. *Explain what happens to a cheek cell when placed in a concentrated salt solution.*
2. *Differentiate between chloroplasts and leucoplasts.*
3. *Why do plant cells have both a cell wall and a cell membrane?*
4. *What is the role of Golgi apparatus in a cell?*
5. *How do mitochondria and chloroplasts suggest an evolutionary connection with bacteria?*
6. *Describe the importance of cell division for living organisms.*

Long Answer Type Questions

1. (*a*) *Describe the structure of the nucleus and its role in the cell.*
   (*b*) *What are chromosomes and what is the position of DNA in chromosome?*
2. (*a*) *Explain osmosis with the help of an experiment.*
   (*b*) *What is the difference between osmosis and diffusion?*
3. *Describe the different types of cell organelles found in a eukaryotic cell and their functions.*
4. (*a*) *Compare mitosis and meiosis.*
   (*b*) *Why are both types of cell division important for living organisms?*
5. (*a*) *Explain the Cell Theory.*
   (*b*) *Discuss what happens when cell division is not properly controlled.*
6. *Draw a well-labelled diagram of a plant cell and describe the function of any five organelles.*
7. (*a*) *Describe the structure of the cell membrane according to the fluid-mosaic model.*
   (*b*) *Explain how substances move across the cell membrane.*

OBJECTIVE TYPE QUESTIONS

Choose the correct option in the following questions:

1. *The basic unit of life is:*
   (*a*) Tissue (*b*) Organ
   (*c*) Organism (*d*) Cell
2. *Selectively permeable membrane allows:*
   (*a*) All substances to pass
   (*b*) Only certain substances to pass
   (*c*) No substance to pass
   (*d*) Only gases to pass
3. *Which organelle is involved in lipid synthesis?*
   (*a*) RER (*b*) SER
   (*c*) Ribosome (*d*) Lysosome
4. *Chromosomes are made up of:*
   (*a*) Lipids and carbohydrates
   (*b*) DNA and proteins
   (*c*) RNA and lipids
   (*d*) Proteins and carbohydrates

(b) *Match the following items given in Column A with that in Column B:*

	Column A		Column B
1.	Mitosis	(*a*)	Gamete formation
2.	Meiosis	(*b*)	Powerhouse of cell
3.	Nucleus	(*c*)	Growth and repair
4.	Mitochondria	(*d*)	Controls cell activities
5.	Vacuole	(*e*)	Stores water and minerals

Assertion-Reason Questions:

Directions: *For Questions number (i) to (v), two statements are given — one labelled as Assertion (A) and the other labelled as Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.*

(*a*) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).

(*b*) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of Assertion (A).

(*c*) Assertion (A) is true, but Reason (R) is false.

(*d*) Assertion (A) is false, but Reason (R) is true.

(i) **Assertion (A):** Red blood cells (RBCs) in humans lack a nucleus.

Reason (R): The absence of a nucleus provides more space for haemoglobin.

(ii) **Assertion (A):** Diffusion requires a selectively permeable membrane.

Reason (R): Diffusion is the movement of particles from higher to lower concentration.

(iii) **Assertion (A):** The cell wall is selectively permeable.

Reason (R): The cell wall allows water and dissolved minerals to pass through freely.

(iv) **Assertion (A):** Viruses are cellular organisms.

Reason (R): Viruses are composed of genetic material with a protein coat.

(v) **Assertion (A):** Cellulose in diet acts as roughage.

Reason (R): Cellulose forms the cell wall of plant cells.

Scan for Answers

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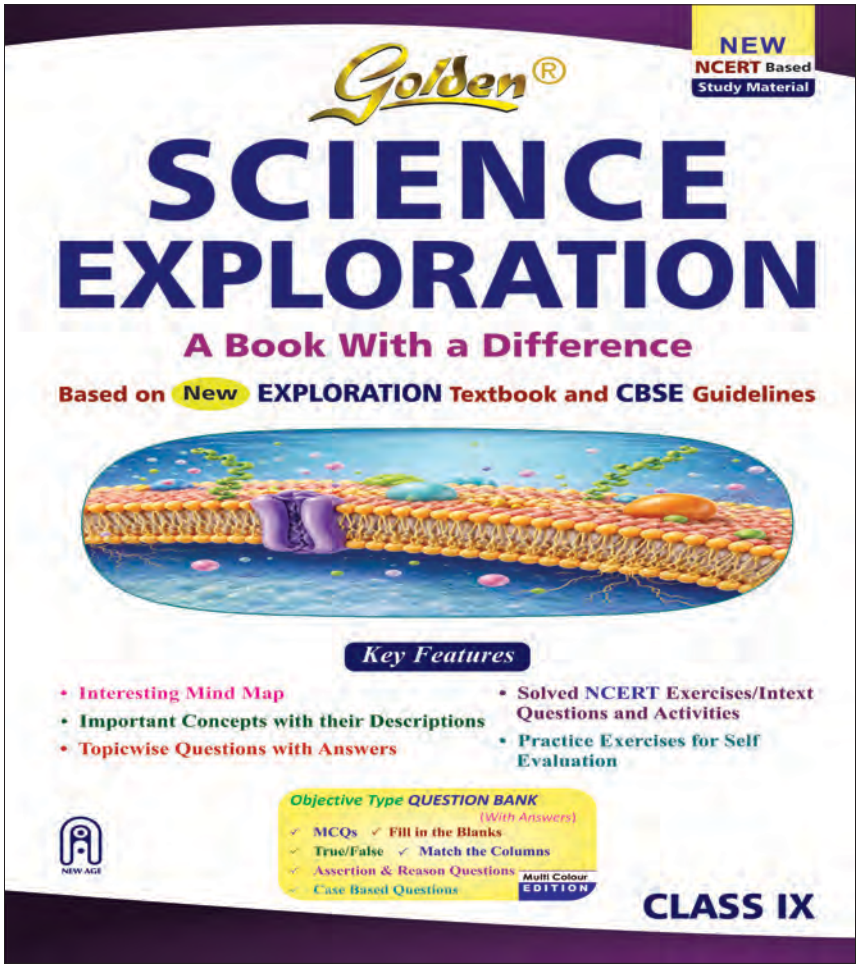

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